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AUTHOR Haney, James E.
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ABSTRACT

Various types of games are useful in the educational process both in school and beyond. This paper discusses some types and uses of games, as well as the issues involved, under these headings: nature of the learning process, educational games, nonsimulation games, gaming-simulations, simulations in urban planning, and gaming-simulations as planning tools. Some games developed at the University of Michigan are described under the appropriate headings. (VT)

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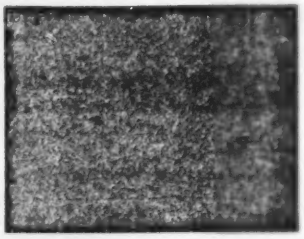
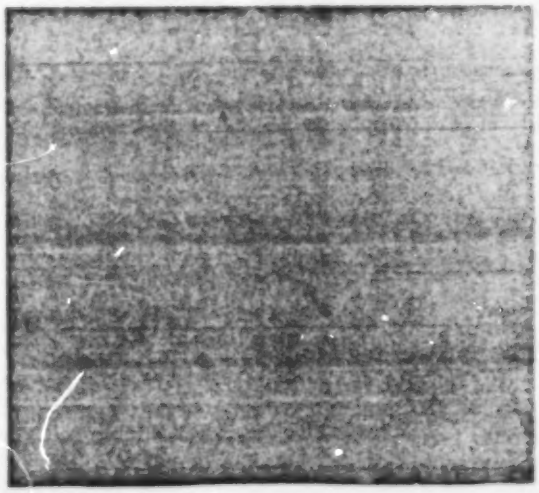
GAMES SIMULATIONS AND LEARNING





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Writer
James E. Haney

Consultants
Layman E. Allen
Richard D. Duke
William A. Gamson
Frederick L. Goodman

Designer
Cyril Barnes

Printed by
the University
of Michigan
Printing Office

ALL THE WORLD'S A STAGE,

AND ALL THE MEN AND WOMEN MERELY PLAYERS:

—*As You Like It*

THE field of gaming theory has its share of semantic quicksand, but anyone interested in questions of how humans learn should take a running jump into it anyway. The promise is that beneath the surface there is a great deal of pedagogical oil. This informal discussion of the terrain touches lightly on some terms and concepts in gaming theory before describing some of the work of a few gamesmakers on campus—Layman Allen, William Gamson, Frederick Goodman, and Richard Duke.

The term "game," like "man" and "life," has a variety of interrelated meanings: sport, play, frolic, fun, amusement, diversion, scheme, art, method, contest, procedure, occupation, life itself. The view that life is a game and man is *homo ludens*—the playing animal—has some respectable credentials in Greek and Elizabethan and modern drama, and in innumerable treatises on questions of how scientists and artists explore reality. Whether man is viewed as a child of God, a prisoner of Fate, a reasoning animal, a political animal, an economically or libidinously determined animal, a playing animal—or some combination of all of these—seems to depend on how the viewer handles the question of uncertainty in human existence. In any case, gaming theorists, in attempting to define the essential features of educational games, are very interested in this matter of uncertainty. Most of them hold that for a game to be a game it must have players, rules, uncertainty, terminating situations, and payoffs for the players. That uncertainty seems to be an essential element of all games is perhaps most evident in sporting contests in which players have to observe rules while exercising skills with an intent to resolve uncertainty by winning. In discussing two kinds of uncertainty, however—intrinsic and extrinsic, or subjective and objective—gamesmakers often use the game of Tick, Tack, Toe as an illustration. This game offers uncertainty for a naive player because he cannot predict the outcome of his moves. But for a player who knows that a countermove (a mark) in the center square will always gain him at least a draw, the uncertainty (and challenge) of the game is greatly reduced. When both players know this, uncertainty disappears, and so does the game. When both players are naive, both have intrinsic or subjective uncertainty about the outcome, and, because of this, the game has an extrinsic or objective uncertainty.

Gaming theorists are not in complete agreement about how games, simulations, models, and theories relate to each other, but some idea can be given here of how some gamesmakers relate the concepts. They frequently define "simulation" in a narrower sense than "anything that has the appearance of or performs the functions of something else." Some regard simulation as a particular kind of *model*, and a model as a particular way of expressing *theory*. A theory (a statement about some aspect of reality) might be expressed verbally ("Humans will learn what they want to learn") or mathematically ("$E = mc^2$") or physically and visually (Watson and Crick's ball-and-rod model of the

I ALWAYS PAINT FAKES.

—PICASSO

DNA molecule as a double helix—constructed, says Watson, by first putting up elements they were sure of, then "fiddling around" with placement of other elements they knew had to be included somewhere). A model is usually regarded as a static system which represents the *structure* of the real-world system under consideration, but not its *functions* or dynamic processes which operate and perhaps change over time. When functional relations and processes are added to a model, it becomes a dynamic representation of a real-world system—a *simulation*. Simulations may or may not include human participants, depending on what real-world system the researcher is attempting to simulate. But when a simulation does include humans engaged in some competitive/cooperative set of activities, the game or contest is usually called a *gaming-simulation*.

All simulations are simplifications, distortions, caricatures of the real-world systems they represent, but this does not mean that they are of no use to researchers and students. A simulation is economical, observable, controllable, reproducible, and changeable; researchers can change and improve its simulative capabilities in successive trials or stages (which is what researchers and students have been doing with games and gaming-simulations in many different subject areas). These "working models" often represent a midpoint somewhere between the complexity, uncontrollability, and nonreproducibility of real-world social phenomena, and, on the other hand, the distortions and ungeneralizability of more completely controlled laboratory experiments.

LANGUAGE AS SIMULATION

Gaming theorists do not necessarily find the definition of a language system as a gaming-simulation very practical or useful, but semanticists, linguists, and other linguophiles can be enthusiastic about this idea. Before proceeding to a discussion of the way games-makers differentiate between nonsimulation games and gaming-simulations, this very broad use of the term should be mentioned.

When a speaker says that he wants to "pursue" a question, or to note something "in passing," the words "pursue" and "passing" are quite obviously metaphors employed to simulate physical experiences. Other words are less obviously metaphors, but whether they are or not does not depend upon whether they are constantly recognized as such. Most semanticists hold that all words are metaphors—symbolic simulations of a reality that lies "out there someplace, beyond words or other symbols." (The Greek term for "word" is "*mythos*.") If all words are metaphors or similes, then all speaking, listening, writing, and reading activities are interactive *exercises* participated in by humans who have

arbitrarily agreed upon certain *rules of play*. These rules are the meanings of individual words, and of propositions or statements made about reality by combining words according to other arbitrarily-agreed-upon *rules of logic*. The simulation system we call English has about 500,000 words or "minirules," of which we ordinarily use only about 25,000 or 30,000; the "maxirules" of logic and rhetoric are no more than a dozen or a score in number, depending upon how they are defined. In any event, conversational games participated in by speakers and listeners, or writers and readers, are most enjoyable and interesting for participants when all have roughly an equal knowledge of the minirules and maxirules and are committed to following them.

For many people a description of language as a gaming-simulation does not "make sense" (which is an interesting metaphor in itself). It is evidently difficult for them to accept the idea that words are symbols and no more than that. Yet there are several ways of personally experiencing the difference between what words are and what they are an attempt to represent. Any effort to translate a word from one language to another offers such an opportunity. The most important learning in such an exercise would appear to be not the discovery of the absolute unequivalency of the two terms, but the secondary and derived discovery of the arbitrariness and artificiality of both of the languages. The same difficulty is encountered in attempts to transfer rules of grammar (logic) from one language to another (as when grammatical rules applying to Latin and Greek were mistakenly superimposed on English for several centuries).

'WHEN I USE A WORD'
HUMPTY DUMPTY SAID
IN RATHER A SCORNFUL TONE
'IT MEANS JUST WHAT
I CHOOSE IT TO MEAN—
NEITHER MORE NOR LESS.'

—LEWIS CARROLL
Through the Looking Glass

METAPHORS OF THE LEARNING PROCESS

The conception of language as gaming-simulation is not entirely irrelevant to problems of deciding how best to challenge students in the classroom or out of it. One problem in disagreements over teaching methods is that parties to the debate hold conflicting notions of what the learner's mind is and how it functions. One simple metaphor commonly used pictures the learner's mind as a bin or box to be filled by the teacher. When the bin is considered "full" or "full enough" of pre-selected facts and concepts, it is issued a certificate to that effect, and sent out into the world. One problem with this metaphor is that it fails to explain why the lid is closed so much during a typical school career. However, if the metaphor itself has been pounded into the bin over a period of twelve or sixteen years, this is a possible explanation of why so many products of the American educational system look upon their "education" as a commodity rather than a continual process.

Another and more complex metaphor of the learning process is much more acceptable to gamesmakers and other

learning theorists. It pictures the mind of the learner as an active system or organism which can assimilate or ingest facts and concepts only if three interactive conditions are present in the learning situation: (1) The learning system is attentive to or engaged with the outside stimuli; (2) The stimuli are in such a form as to be capable of recognition ("re-cognition") by the system as it is then constituted; and (3) The stimuli pose no significant threat to the integrity or "integratedness" of the learning system. Condition (3) here is, in one sense, a restatement of condition (2); what cannot be recognized is often a threat. In this metaphor, the learner's mind is an active and yet self-protective decision-network which ignores most other environmental influences as it seizes on, inspects, compares, and tries to "make sense" out of particular stimuli before it accepts or rejects them. Data perceived as compatible enough with the present state of the system (both "rationally" and "emotionally") are absorbed into it, thereby *changing* the internal organization of the system itself. The process of assimilation is called the learning process; what is learned is what is changed in the system.

If the test of any metaphor or "minitheory" is its ability to describe what seems to be happening in the real world, the test of the metaphor of "learner's mind as active system" is whether it can explain more about how humans learn than other and usually simpler metaphors. The testing of this or any other metaphor in real-life learning situations is complicated, partly because the three conditions—attentiveness, relatability, and non-threat—are posited as qualities or properties of the individual learner's system, not of the teacher's. What one student can attend to, examine, and assimilate as relatable and non-threatening, another student of ostensibly or presumably the same background and "state of readiness" may not be able to assimilate. The metaphor implies that the first obligation of the learning system is to its own stability and integrity; stimuli which are unassimilable for whatever reason are rejected, screened out, "tuned out," "turned off."

Educators who use the above-mentioned or similar metaphors of the learning process are in a position to appreciate such seemingly paradoxical statements as "There are no teachers; there are only learners."

EDUCATIONAL GAMES

Gamesmakers frequently define an educational game as a competitive cooperative exercise which teaches something other than merely the rules of the game. What educational games and gaming-simulations apparently provide is an environment within which participants undergo formative experiences that often change their attitude toward the subject matter under consideration. The personal involvement demanded of a participant in an educational game or gaming-simulation seems to induce a form of active and rapid learning of systematic relations among elements of a complex subject matter—relations which are difficult to assimilate through the linear and necessarily discursive means of listening to lectures or reading strings of symbolic marks on paper. How potent, reliable, valid, or efficient many educational games and simulations are has not yet been established, partly because measuring instruments capable of establishing fair comparisons between games and other modes of instruction have not yet been developed. What seems evident, however, is that educational games can teach simulative skills, and educational gaming-simulations can allow students better opportunities for applying these skills than do many other methods of instruction. To distinguish games from gaming-simulations, the former are frequently called "nonsimulation games."

NONSIMULATION GAMES

Professor Layman E. Allen, of the Law School and Mental Health Research Institute, has developed several nonsimulation games — WFF 'N PROOF, ON-SETS, EQUATIONS, THE REAL NUMBERS GAME, QUERIES 'N THEORIES—designed to interest children in learning and practicing skills basic to all human learning. WFF 'N PROOF teaches symbolic logic; ON-SETS, EQUATIONS, and THE REAL NUMBERS GAME teach basic mathematical concepts; and QUERIES 'N THEORIES teaches the art of asking good questions. The earliest developed and most widely used of these is WFF 'N PROOF, which began evolving in 1956 and was first marketed in 1961. The game grew out of a three-year reseach project called ALL (Accelerated Learning of Logic), conducted at Yale University with support from the Carnegie Corporation. The object of the project was to develop better methods of introducing symbolic logic into elementary school curricula, and there is little doubt about the success of the work; games in the WFF 'N PROOF series are now used in hundreds of school systems throughout the U.S., not only in elementary schools but high schools and colleges.

WFF 'N PROOF is actually not one game but a series of twenty-one games of increasing complexity. The first games in the series are simple enough to be enjoyed by first graders; the final games can be challenging to university teachers of logic. The series is marketed in a book-sized kit, complete with playing mats, thirty-six die-like symbol cubes, and a 224-page programed instruction manual (The first game is explained in roughly the first twenty pages). The twenty-one-game series introduces and uses thirteen ideas: the definition of a WFF ("woof," or Well-Formed Formula):

definition of a PROOF; and eleven rules of inference. The game rules (which are distinct from the subject matter of the game) are designed so that each player must give the game his constant and full attention. To win the game, a player must solve a series of problems set for him by his fellow players. The others, in turn, must solve problems that he has set. This places a premium on creating and solving problems which are at the outer limits of the player's knowledge of the subject matter. When players are evenly matched, each is able to solve most of the problems posed for him; thus he receives the immediate reinforcement provided by success. Because he views the problems as difficult, his self-confidence is enhanced. Because he wants to win, he is motivated to attempt mastery of further subject matter.

When WFF 'N PROOF is used in classrooms, the teacher's role shifts toward more individualized instruction than is usual in most classrooms. She serves primarily as an adjudicator of differences that inevitably arise between two or three players. Instead of expounding subject matter to a large and mainly passive group, she is supplying much-needed information to a small group of active participants. Teachers can ensure that each player is working with other players on his level by arranging a hierarchy of game tables, with players matched initially according to the teacher's knowledge of performance in several tryout games. After each session of play, losers are bumped down one table and winners up one table. This kind of tournament structure with WFF 'N PROOF has been extended to intra- and inter-school tournaments, and to competitions between school systems in half a dozen states. The idea of interscholastic competition was suggested by James Coleman in 1961 as a way of introducing into American high schools a reward for mental talent comparable to the rewards for physical talents displayed in athletic competition.

How effective is WFF 'N PROOF? Does it teach what it was designed to teach? Evidence is that it does. In keeping with the Horatian precept, "to delight, or instruct, or both," teachers and players testify that it transforms the learning process, and *that* transforms the learner's attitudes toward himself, his capacities, and what it is to learn and know. The effects of the game were formally tested in 1964, when forty-three junior high and high school students studied and played it in a summer-school course on logic conducted at a suburban California high school. The California Test of Mental Maturity, 1957 S Form, Junior High School and Advanced, was used in a pre-test and post-test of both the experimental and control groups. Both groups were voluntarily enrolled in their respective courses, which were taught by different teachers. The WFF 'N PROOF group achieved a mean increase of over twenty points on the non-language part of the test, while the control group gained less than seven points.

QUERIES 'N THEORIES, developed by Professor Allen in association with Peter Kugel of MIT and Joan Ross of

THE FUNCTION

OF THE SCHOOL

IS TO INTEREST STUDENTS

IN WHAT THEY

SHOULD BE INTERESTED IN

BUT ARE NOT

—ROBERT M. HUTCHINS

the Mental Health Research Institute, was published in 1970 after five years of experimentation and development. The game is designed to develop the basic human skill of asking good questions. Players try to detect the properties of a generative language that one of the players (the Native) has secretly defined by building a set of Basic Sentences and Replacement Rules. Some of the rules are based partly on ideas developed by Noam Chomsky, whose work has revolutionized modern linguistics. Although QUERIES 'N THEORIES was originally intended to deal only with linguistics, the generative rules embodied in the game develop skills relevant to scientific theorizing and experimental design in a number of disciplines. Like WFF 'N PROOF, QUERIES 'N THEORIES is a series of games of increasing complexity. As the game level increases, languages the players can build begin to exhibit some of the richness of natural languages such as English or Spanish.

GAMING-SIMULATIONS

Several games developed by Michigan faculty members differ from Professor Allen's in their structure and purposes. Gaming-simulations in the social sciences, in contrast with the WFF 'N PROOF games, are designed to give students personal experience in solving problems of cooperation and conflict implicit in a variety of real-world social systems. The games of SIMSOC, COMMUNITY, POLICY NEGOTIATIONS, and M.E.T.R.O.-APEX simulate different kinds of systems and vary considerably in their subject matter, structure, scope, complexity, and mode of operation. What they share, however, is the capacity to provide students with a personal experience of what it is like to be a problem-solver in a complex system. Their personal participation in gaming-simulations allows them to acquire a deeper understanding of how real-world systems function. The differences between abstract knowledge and personal understanding cannot be described (verbally simulated) very clearly, given the present state of ignorance of how the "mind" functions, but gaming participation seems to provide the kind of synthesized learning referred to in the old expression "Experience is the best teacher." Derek Bok, the new President of Harvard, seemed to be alluding to this kind of learning when he remarked recently that undergraduate curricula might be improved by mixing formal studies with work experiences which would allow students to develop attitudes on major personal, moral, and social issues.

The game of SIMSOC (Simulated Society), developed by William Gamson, Professor of Sociology, is designed to make social science materials more vivid or "real" for college-level students. It focuses on the most central problem of any society: the establishment and maintenance of social order. By creating situations within which students must actively question the nature of social order and examine the processes of social conflict and social control, the game can transform a student's attitudes toward assigned readings and classroom discussions, and help him to sympathize and understand what are otherwise too often fragmented materials. The components of the game include geographic regions, resources, private interests, public programs, private consumption, franchises, political parties, a council of law makers, police forces, and four national indicators—food and energy supply, standard of living, social cohesion, and public commitment. Only a few structural rules are furnished in the beginning of the game, so that the social structure evolves from the interaction of players with each other and with the evolving structure as players try to achieve their private objectives and political objectives.

SIMSOC is played in from five to ten sessions of one and one-half to two hours each. The number of participants may range from twenty to sixty, with players using four or more rooms in reasonably close proximity. Players are dependent on each other for survival and achievement of their goals, but the society has no State; it is up to the players to create institutions (especially governmental ones). To do this, they meet with other players who have compatible interests, bargain with those who have conflicting interests, and travel about to influence players in other regions. Options in influencing others include threatening them with arrest and confiscation of their resources. At the end of each session, resources are invested in ways that affect the National Indicators: Food and Energy Supply, Standard of Living, Social Cohesion, and Public Commitment. Everyone is affected by what happens to these indicators, which are altered not only by direct investment but by various other actions of the society members, including absenteeism, arrests, unemployment, and death.

In an early version of the game, death posed an interesting problem in rule formation, because the game rules did not prohibit players from committing "suicide" when they found themselves in altogether untenable circumstances; players would declare suicide and then re-enter the game as new participants. This option had to be ruled out to maintain sufficient realism in the game. Another early finding in game trials was that class grades could not be tied to how well the participants succeeded in establishing a smoothly functioning society. This reduced play to the ordinary college game of students versus instructor; the players would give up their SIMSOC-assigned "private" interests in the society to ensure the collective good—a good grade in the course. The result was usually a strongly centralized, collective welfare state controlled by a small group of players. Course grades are now awarded according to the caliber of each student's analysis of SIMSOC sessions and assigned readings in de Tocqueville, Hobbes, Locke, Mill, Etzioni, Dahl, Blau, Coleman,

and other theorists. The dissociation of grades from game participation has had no effect on degrees of participation, partly because the game is enjoyable and invites participation, and because effective analyses of it are more or less dependent upon insights gained through participation.

COMMUNITY, a gaming-simulation developed by Frederick Goodman, Professor of Education, is also designed to raise basic questions about how a community really functions, but it is a simpler game more suited for participants who have less theoretical background than SIMSOC players. Participants assume roles as citizens, property owners, wage earners, police, judge, and "the government," using a three-foot game board, marbles as money and other resources, and wooden dowels whose varied lengths represent each participant's "power" within the community. At the beginning of play, the rules are few and citizens' roles deliberately undefined. But as play proceeds, participants are free to add new rules as they attempt to achieve more power, increase their income, keep the government from going bankrupt, and maintain sufficient police power to maintain order and protect resources. As with SIMSOC, the game is designed to give players personal experience of what it is like to be a slum dweller, industrialist, lawmaker, judge, police official, and so forth. The game has been played by community officials, police, and school administrators, and is now being used in the Highland Park school system, in the Detroit area. A comment typical of students who have played the game is "I never realized the government had so much to do."

POLICY NEGOTIATIONS, another instructional gaming-simulation developed by Professor Goodman, is actually a priming game for a gaming-simulation process that participants are expected to embark upon once they have mastered the basic structure of POLICY NEGOTIATIONS. After they have learned how to play the game, they design a new gaming-simulation by modifying the original game to suit their particular situation or interests. The subject matter of simulations based on POLICY NEGOTIATIONS can be any process during which representatives of various constituencies interact to allocate limited resources. In the priming game, the limited resource is influence. The situation it presents involves negotiations between teachers and a school board: Three teachers represent three different constituencies of teachers; three school board members represent three different constituencies of property owners. Each of the six players begins the game with a specified amount of prestige and a specified amount of influence, and they negotiate on some twenty-four issues. Fifteen of the issues can be decided by direct action of the players, but the rest can be decided only by a larger community in an "election." Two other structural elements in the priming game include external forces which can influence decisions (a newspaper, chamber of commerce, labor unions, a civil rights group), and external events which are introduced by the game leader at the beginning of each session of play.

THE CITY IS THE CENTER OF PARALYSIS

—JAMES JOYCE

In experimental trials of POLICY NEGOTIATIONS, Professor Goodman has found that most playing groups can readily move from the priming game to creation of a gaming-simulation adapted to their particular situations and interests. Thus this "game-generating game" or "simulation-generating simulation" has some potential for wide application to problems of conflict management in a variety of real-world contexts.

SIMULATIONS IN URBAN PLANNING

Some of the most complex and sophisticated gaming-simulations in existence have been developed to probe city and metropolitan planning activities. M.E.T.R.O.-APEX, a computer-assisted game on this subject, is a complex educational device developed by Professor Richard Duke, of the Environmental Simulation Laboratory in the School of Natural Resources. The purpose of the game is to demonstrate to students (including professional urban planners and government officials) how alternative chains of decisions affect patterns of metropolitan growth over a period of several years. The game offers players over twenty-five different roles (as Politicians, Planners, Industrialists, Real Estate Developers, or Air Pollution Control Officers), with each having to make individual and joint decisions during each four-hour session (which represents one year). At the end of each session, these decisions are fed into computer programs which simulate the "environment." As each succeeding session begins, the players are confronted by conditions created partly by their previous decisions and partly by variables over which they have no control.

M.E.T.R.O.-APEX models a metropolitan area of 320 square miles and, initially, 227,000 people categorized into five different levels of socio-economic households. Other elements include a Central City, a Suburb, Townships in process of urbanization, an overspanning County Board, and several different types of industry. Players have to cope with, among other things, Municipal and County budgets, tax rates and revenues, bonding proposals, special millage requests, rezoning problems, public capital improvement projects, industrial production decisions, unemployment, enticement of new industry, air pollution control funding and enforcement questions, public opinion polls, and political campaign contributions (Politicians must stand for re-election every second session), as they try to achieve objectives they have chosen within broad limits established by the various roles. The Planner roles in APEX are lifelike: Planners have no direct power to make decisions or spend money; they can succeed only by developing strategies for sound community development and then convincing others, particularly the Politicians and Developers, that their recommendations are reasonable.

THE CITY

NO LONGER EXISTS

EXCEPT AS A CULTURAL GHOST

FOR TOURISTS

ANY HIGHWAY EATERY

WITH ITS TV SET

NEWSPAPER AND MAGAZINE

IS AS COSMOPOLITAN

AS NEW YORK

OR PARIS

—MARSHALL MC LUHAN

In general, the gaming-simulation illustrates the interplay between private economic decisions and governmental decisions, and the consequences of that interplay on the physical and economic development of the metropolitan area.

M.E.T.R.O.-APEX was developed in 1969 as a special version of an earlier gaming-simulation, M.E.T.R.O. (1966), which itself evolved from a prototype named *Metropolis* 1963). The current APEX (Air Pollution Exercise) version of M.E.T.R.O., developed with support from the U.S. Public Health Service, is now used regularly in short courses for federal and local air pollution control officers at the Air Pollution Control Institute of the University of Southern California. Professor Duke and his associates are now working on a new version of M.E.T.R.O., to be called M.E.T.R.O.-'71; and future versions of the game will be identified similarly—by the basic name plus the year of development.

GAMING-SIMULATIONS AS PLANNING TOOLS

Can real cities and metropolitan authorities effectively employ real computer-assisted projective simulations to achieve better planning decisions? Many authorities have sponsored studies of this kind, particularly in transportation planning. The problem, says Professor Duke, is that planners have concentrated on transportation planning—and particularly highway transportation—to the exclusion or severe undervaluation of other factors that vitally affect the quality of life of metropolitan populations. If more comprehensive planning is to be achieved, planners need to acquire access to data which adequately reflect the values, interests, and concerns of the man on the street. No American city or metropolitan authority now regularly obtains such data. Proposals advocating procedures for regular collection of such data in sufficient scope and depth to support high-quality planning activities often encounter public opposition on several grounds. One is that such activities are too expensive to be justifiable; another is that possession of such data by elite groups of men and computers will only erode the little control the ordinary citizen now exercises over public planning activities which affect the quality of his existence. Thus, ironically, as Gunnar Myrdal has put it, the fear of loss of individual freedom has been expressed as a distrust of centralized planning in American urban development, so that city dwellers are free to live amidst chaos and decay.

How effective urban planning can be in future depends partly upon whether social scientists can devise effective means of showing the body politic the dilemma of community life: that the sum of individual interests adds up to a disadvantage for all. As Professor Anatol Rapoport has put it, "We have been too long accustomed to the uncritical acceptance of the laissez faire principle, namely, that a totality of individuals seeking their respective self-interests by *short-sighted* calculations will move toward the realization of this self-interest by the operation of economic laws derived from the assumptions of a free competitive market economy."

If longsightedness is one of the things that education is all about, then Professors Allen, Gamson, Goodman, Duke, and their associates seem to be in the thick of the fight (to use an old simulation of physical reality) to develop better means of bringing it about.

The *Research News*, published monthly by the Office of Research Administration of The University of Michigan, attempts to serve interested readers both inside and outside the academic community by reflecting the diverse forms of modern university research. Some issues survey a general area of research; some are focused on organizational units; others describe long-range undertakings; and still others provide a basic introduction to some subject. Throughout the diversity of subject and approach, however, there is a consistent attempt to interpret matters of general interest in terms of particular efforts, and to give some idea of the forms in which these efforts are expressed at one large university. Current issues of the *Research News* are distributed without charge. A complete file, dating from 1952, can be purchased on microfilm from University Microfilms, 300 North Zeeb Road, Ann Arbor, Michigan 48103. Correspondence concerning the *Research News* should be addressed to the Editorial Office, Office of Research Administration, The University of Michigan, Ann Arbor, Michigan 48105.

Donald E. Thackrey
Editor and
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